

We Claim:

1. A cyclone separator for separating a material from a fluid comprising a longitudinally extending body having a wall extending around an internal cavity, the wall having an inner surface, the internal cavity having, in transverse section, an inner portion in which the fluid rotates when the separator is in use and at least one outer portion positioned external to the inner portion and contiguous therewith, the outer portion of the cavity extending outwardly from the inner portion of the cavity and defining a zone in which at least a portion of the fluid expands outwardly as it rotates in the plane defined by the transverse section, the portion of the fluid in the outer portion of the cavity having different fluid flow characteristics compared to those of the fluid rotating in the inner portion of the cavity which promote the separation of the material from the fluid.
2. The separator as claimed in claim 1 wherein the inner surface of the wall is configured to impart changes in the rate of acceleration to the portion of the fluid as it rotates in the plane defined by the transverse section.
3. The separator as claimed in claim 1 wherein the wall is configured to continuously impart changes in the rate of acceleration to the fluid as it rotates in the plane defined by the transverse section.
4. The separator as claimed in claim 1 wherein the wall interacts with the portion of the fluid to impart to the portion of the fluid a different speed, a different direction of travel or a different

velocity compared to that of the fluid rotating in the inner portion of the cavity.

5. The separator as claimed in claim 1 wherein the cavity has a plurality of outer portions.

6. The separator as claimed in claim 1 wherein the inner surface of the wall is configured to interact with the portion of the fluid to create a dead air space in the outer portion of the cavity.

7. The separator as claimed in claim 6 wherein the dead air space extends longitudinally in the same direction as the separator.

8. The separator as claimed in claim 1 wherein the outer portion has a receiving portion for receiving the material which is separated from the fluid.

9. The separator as claimed in claim 8 wherein the separator is vertically disposed and the receiving portion is positioned towards the lower end of the separator and comprises a collecting chamber in which the separated material is collected.

10. The separator as claimed in claim 8 wherein the separator has an upstream end and a downstream end and the receiving portion is positioned towards the downstream end of the separator and is in flow communication with a chamber downstream thereof.

11. The separator as claimed in claim 5 wherein the inner surface of the wall around each of the outer portions is configured to

93/ interact with the portion of the fluid to create a dead air space in each of the outer portions of the cavity, and each of the dead air spaces extends longitudinally in the same direction as the separator.

5 12. The separator as claimed in claim 11 wherein each of the outer portions has an upstream end and a downstream end, the upstream end of at least one of the portions longitudinally positioned at a portion of the inner surface different to the position of the upstream end of another outer portion.

10 13. The separator as claimed in claim 12 wherein the upstream end of at least one of the outer portions is longitudinally positioned at a portion of the inner surface adjacent the downstream end of another outer portion.

15 14. The separator as claimed in claim 1 wherein the rotation of the fluid in the inner portion defines a first cyclone and the inner surface of the wall is configured to interact with the portion of the fluid to cause the portion to rotate to define at least one second cyclone exterior to the first cyclone.

20 15. The separator as claimed in claim 5 wherein the rotation of the fluid in the inner portion defines a first cyclone and the inner surface of the wall around each of the outer portions is configured to interact with the portion of the fluid to cause the portion to rotate to define at least one second cyclone exterior to the first cyclone in each of the outer portions.

16. The separator as claimed in claim 1 wherein the rotation

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of the fluid in the inner portion defines a first cyclone and the inner surface of the wall around the outer portion is configured to interact with the portion of the fluid to create a dead air space in the outer portion of the cavity and to cause the portion to rotate to define at least one second cyclone exterior to the first cyclone.

17. The separator as claimed in claim 1 wherein the fluid which is introduced into the cyclone comprises a gas which has a material selected from the group consisting of solid particles, a liquid, a second gas and a mixture thereof contained therein and a portion of the material is removed from the gas as the gas passes through the separator.

18. The separator as claimed in claim 1 wherein the fluid which is introduced into the cyclone comprises a liquid which has a material selected from the group consisting of solid particles, a second liquid, a gas and a mixture thereof contained therein and a portion of the material is removed from the liquid as the liquid passes through the separator.

19. The separator as claimed in claim 1 wherein the fluid which is introduced into the cyclone comprises at least two fluids having different densities and the inner wall includes at least a portion which is configured to decrease the rate of acceleration of the fluid as it passes through that portion of the separator.

20. The separator as claimed in claim 1 wherein the separator comprises a dirt filter for a vacuum cleaner.

21. The separator as claimed in claim 1 wherein the separator comprises an air inlet for turbo machinery.

5 22. The separator as claimed in claim 1 wherein the separator comprises treatment apparatus positioned upstream of a fluid pump.

10 23. The separator as claimed in claim 1 wherein the separator comprises treatment apparatus positioned upstream of a pump for a gas.

24. The separator as claimed in claim 1 wherein the separator comprises treatment apparatus positioned upstream of a pump for a liquid.

15 25. The separator as claimed in claim 5 wherein the outer portions are positioned symmetrically around the inner portion.

26. The separator as claimed in claim 5 wherein the outer portions are positioned non-symmetrically around the inner portion.

20 27. The separator as claimed in claim 5 wherein the outer portions extend contiguously around the inner portion.

23 28. The separator as claimed in claim 1 wherein the transverse cross-sectional area of the outer portion is less than the transverse cross sectional area of the inner portion.

24 29. The separator as claimed in claim 1 wherein the transverse cross-sectional area of the outer portion is the same as the

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transverse cross sectional area of the inner portion.

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30. The separator as claimed in claim 1 wherein the transverse cross-sectional area of the outer portion is greater than the
5 transverse cross sectional area of the inner portion.

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31. The separator as claimed in claim 1 wherein the outer portion comprises a helix.

32. A cyclone separator for separating a material from a fluid comprising a longitudinally extending body having a wall which, in transverse section, extends in a continuous closed path, the wall having a non-baffled inner surface which defines an internal cavity, the internal cavity having an inner portion in which the fluid rotates
15 when the separator is in use, and at least one outer portion positioned external to the inner portion and contiguous therewith defining a zone in which the wall is configured to impart to at least a portion of the fluid as it rotates in the plane defined by the transverse section different fluid flow characteristics compared to those of the fluid
20 rotating in the inner portion of the cavity which promote the separation of the material from the fluid.

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33. The separator as claimed in claim 32 wherein the wall is configured to impart changes in the rate of acceleration to the portion
25 of the fluid as it rotates in the plane defined by the transverse section.

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34. The separator as claimed in claim 32 wherein the wall is configured to direct the portion of the fluid into the outer portion of the cavity.

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35. The separator as claimed in claim ²⁷32 wherein the wall interacts with the portion of the fluid to impart to the portion of the fluid a different speed, a different direction of travel or a different velocity compared to that of the fluid rotating in the inner portion of the cavity.

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36. The separator as claimed in claim ²⁷32 wherein the cavity has a plurality of outer portions.

10 37. The separator as claimed in claim ²⁷32 wherein the inner surface of the wall is configured to interact with the portion of the fluid to create a dead air space in the outer portion of the cavity.

15 38. The separator as claimed in claim 37 wherein the dead air space extends longitudinally in the same direction as the separator.

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39. The separator as claimed in claim ²⁷32 wherein the outer portion has a receiving portion for receiving the material which is separated from the fluid.

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40. The separator as claimed in claim ⁴⁰39 wherein the separator is vertically disposed and the receiving portion is positioned towards the lower end of the separator and comprises a collecting chamber in which the separated material is collected.

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41. The separator as claimed in claim ⁴⁰39 wherein the separator has an upstream end and a downstream end and the receiving portion is positioned towards the downstream end of the

separator and is in flow communication with a chamber downstream thereof.

42. The separator as claimed in claim 36 wherein the inner surface of the wall around each of the outer portions is configured to interact with the portion of the fluid to create a dead air space in each of the outer portions of the cavity, and each dead air space extends longitudinally in the same direction as the separator.

43. The separator as claimed in claim 42 wherein each of the outer portions has an upstream end and a downstream end, the upstream end of at least one of the portions longitudinally positioned at a portion of the inner surface different to the position of the upstream end of another outer portion.

44. The separator as claimed in claim 43 wherein the upstream end of at least one of the outer portions is longitudinally positioned at a portion of the inner surface adjacent the downstream end of another outer portion.

45. The separator as claimed in claim 32 wherein the rotation of the fluid in the inner portion defines a first cyclone and the inner surface of the wall is configured to interact with the portion of the fluid to cause the portion to rotate to define at least one second cyclone exterior to the first cyclone.

46. The separator as claimed in claim 32 wherein the rotation of the fluid in the inner portion defines a first cyclone and the inner surface of the wall around the outer portion is configured to interact

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The separator as claimed in claim 3 comprises a dirt filter for a vacuum cleaner.

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52. The separator as claimed in claim 32 wherein the separator comprises treatment apparatus positioned upstream of a pump for a liquid.

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The separator as claimed in claim ~~36~~³¹ wherein the outer portions are positioned symmetrically around the inner portion.

~~54.~~³⁹

5 The separator as claimed in claim 37 herein the outer portions are positioned non-symmetrically around the inner portion.

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The separator as claimed in claim ~~36~~³¹ wherein the outer portions extend contiguously around the inner portion.

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~~56.~~⁴⁵

The separator as claimed in claim ~~32~~²⁷ wherein the transverse cross-sectional area of the outer portion is less than the transverse cross sectional area of the inner portion.

~~57.~~⁴⁶

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The separator as claimed in claim ~~32~~²⁷ wherein the transverse cross-sectional area of the outer portion is the same as the transverse cross sectional area of the inner portion.

~~58.~~⁴⁷

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The separator as claimed in claim ~~32~~²⁷ wherein the transverse cross-sectional area of the outer portion is greater than the transverse cross sectional area of the inner portion.

~~59.~~⁴⁸

The separator as claimed in claim ~~32~~²⁷ wherein the outer portion comprises a helix.

~~60.~~⁴⁹

A cyclone separator for separating a material from a fluid comprising a longitudinally extending separator having a wall, the wall having an inner surface and defining an internal cavity within which the fluid rotates when the separator is in use, the inner surface of the wall defined by, in transverse section, a continuous non-circular

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convex closed path, the cavity having an inner portion positioned within the non-circular convex closed path and at least one outer portion between the inner portion and the non-circular convex closed path.

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61.

The separator as claimed in claim ~~60~~⁴⁹ wherein the longitudinally extending body has a longitudinal axis and at least a portion of the longitudinal extent of the inner wall of the separator is defined by a curve swept 360 degrees around the axis along the continuous non-circular convex closed path.

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The separator as claimed in claim 61 wherein one portion of the continuous non-circular convex closed path defines a dead air space in which a portion of the material settles out from the fluid and has a receiving portion for receiving the material which is separated from the fluid in the portion.

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The separator as claimed in claim ~~60~~⁴⁹ wherein the cavity has a plurality of outer portions.

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64.

The separator as claimed in claim 60 wherein the inner surface of the wall is configured to interact with the portion of the fluid to create a dead air space which extends longitudinally in the same direction as the separator.

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The separator as claimed in claim ~~63~~ wherein the rotation of the fluid in the inner portion defines a first cyclone and the inner surface of the wall around each of the outer portions is configured to interact with the portion of the fluid to cause the portion to rotate to

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define at least one second cyclone exterior to the first cyclone in each of the outer portions.

66. The separator as claimed in claim 60 wherein the rotation of the fluid in the inner portion defines a first cyclone and the inner surface of the wall around the outer portion is configured to interact with the portion of the fluid to create a dead air space in the outer portion of the cavity and to cause the portion to rotate to define at least one second cyclone exterior to the first cyclone.

67. The separator as claimed in claim 60 wherein the outer portion of the inner surface of the wall is defined by, in transverse section, at least two of straight lines.

68. The separator as claimed in claim 60 wherein the inner surface of the wall is defined by, in transverse section, a plurality of straight lines which approximate a continuous non-circular convex closed path.